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HYGIENE IN ARCHITECTURE

CARL PFEIFFER.

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SANITARY RELATIONS

TO

HEALTH PRINCIPLES IN ARCHITECTURE.

A paper read at the Annual Meeting of the "American Public Health Association," 1873,

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A REPORT UPON "SANITARY RELATIONS TO HEALTH PRINCIPLES OF ARCHITECTURE."

By CARL PFEIFFER, Architect, F. A. I. A., of New York.

Dr. Mapother has justly remarked that, after medicine, "as professions most concerned in the preservation of public health rank those of the Architect and Engineer." This paper is designed to illustrate the relations of Architecture to the science of Hygiene; a very important relation, since the architect is required to furnish the dwelling in which we pass much of our lives, while the dwelling exercises a more decided influence upon our health than the clothes we wear. Every adult inhales some 360 cubic feet of air in the course of twenty-four hours, and this is but a tithe of the amount which he requires to regulate bodily temperature; but to insure to each individual the full needed amount, accessible to him every hour of the day, his dwelling must be properly constructed.

EQUABLE TEMPERATURE OF VITAL IMPORTANCE.

The feeding and regulation of temperature of the human body is a matter often overlooked, and yet of equal importance. For, so fixed and immutable is this temperature in a healthy body, that the blood of a negro in equatorial Africa, or of a Hindoo in the heats of Asia, is, by no perceptible fraction of a degree warmer than the blood of a healthy Esquimaux near the north pole. The

atmosphere in which these different bodies live may differ as they do, by more than a hundred degrees; but if the clothing and the house do not neutralize this enormous difference, if the temperature of the body is allowed to sink or rise to any perceptible degree, sickness and ultimately death are the result. It is a wonderful hygienic instinct which leads the seal-hunter to build snow-huts, and the European in East India to erect houses with the thickest of walls. Hence, the architect must keep both objects in view if he would not build hospitals and tombs for his clients instead of comfortable and healthy dwellings.

Vast as are the technical requirements which his profession imposes upon him, apart from all sanitary considerations, the science of hygiene further demands from him, that he should study *first*, the climatological and meteorological phenomena of the place where he is to build; *second*, the geological condition of the ground upon which the building is to be erected; *third*, the material of which he is to construct the building; and on the basis of these studies, he must arrange the proposed house in such a manner that it may both feed the human body with air and preserve its normal temperature. How these studies have been neglected, the majority of our public halls, court-rooms, prisons, hospitals, asylums, churches, school-rooms, etc., are melancholy evidences, not to mention private dwellings, tenement houses, and hotels.

And here let me ask you, who have this matter more especially in charge, should not the law which protects

men from adulterated food, and adulterated liquor, exercise its power also to protect him from adulterated air? It is quite true that people get to be fond of adulterated whiskey, coffee, bread, and the like; so fond, indeed, that they seem to prefer them to the pure articles. Thus, if you go into large workshops you will generally find the men bent on keeping fresh air out on coldish days, thinking that if they fill a work-room with the evaporations of their united bodies they will soon make it comfortable. Yet no reasoning is more fallacious than this. It is the fresh air, the cold air from the outside, which has the elements of heat in it, when warmed by a fire, whilst the evaporated air of their own bodies is pregnant with chills, however much warmed.

You will always find, therefore, in closed workshops of *such* a kind, that the workmen clamor for more fire. Why? Because what they conceive to be warming (the evaporation of the bodies of their fellow-workmen), is nothing but deathly iciness. To rid men of the false notion that an adulterated atmosphere which seems warm, is *not* warming, constitutes one of the most difficult problems which you, as well as we architects, have to contend with, since almost all classes of men labor under its delusion.

THE SCIENCE OF VENTILATION.

The special science which has for its object this mediating between the body in this the house, and the atmosphere outside of the house, is called the Science of

Ventilation; Ventilation from *ventus*, *wind*, a moving of air. Hence, the problem of that science is to effect such a moving of the air as may be needed to feed and regulate the temperature of the human body within the house, by means of the house. There are two ways by which the air can be thus set and kept moving. 1st, mechanically, by means of fans, called the system of propulsion; 2d, by means of heated chimneys and flues, called the system of suction. In addition to these methods, much is done by what is called natural ventilation; but this is not to be depended upon at all stages of the weather, nor at all seasons of the year, its operation depending upon three forces, viz.: diffusion, winds, and the difference in weight of masses of air of unequal temperature. I may here add that cleanliness in a building is an indispensable requisite in the proper working of any system of ventilation.

Of the mechanical means of ventilation I shall not attempt to speak here for want of time, beyond saying that in all large buildings, nay, in all large cities, they are indispensable, however costly their arrangement.

Concerning the *second*—it is first to be observed that to some degree every house is of itself necessarily a ventilator; and thankful we ought to be that it is so. Streams of air pour continually from the outside through the walls into the inside, not to say through the ground on which the house stands. These streams may not be sensibly perceptible, as is the water that oozes through the walls and the ground; nevertheless, they are constantly present

and operative. Aye, and so powerful are these currents that you can blow out a candle held against the wall close on the inside of a house from the outside. Every wall (particularly the mortar) is porous, and walls are more porous in proportion as they are less moist, for moisture clogs up the bricks, stone, and mortar, and thus obstructs ventilation. Moist walls, therefore, being almost air-tight are unhealthy in a double way; *firstly*, by the action of their moisture, which draws the heat from our bodies, making us shiver, and causing all sorts of rheumatic complaints; *secondly*, by obstructing the passage of the air. Hence, also, the great unhealthiness of new buildings, to which I desire to call your special attention. Doctor Von Pettenkofer estimates that a newly built house of fifteen rooms and cellar, contains in its materials some 3,300 cubic feet of water, which must be evaporated before the house is properly inhabitable. Please realize this, and say whether or not the law which considers it a duty to provide punishment for the adulteration of food, drinks, etc., ought not by some means to prevent people from occupying newly built houses, wherein it is impossible to breathe aught but adulterated air!

RELATION OF ARCHITECTURE TO HYGIENE.

One of the first principles of architecture in its relation to hygiene is that all the materials of a building should be dry and porous before it is inhabited, and should be subsequently so kept. The very furniture of a house can chill and produce rheumatic affections if it is

damp and has been long in an unheated room, for in that case it acts as a power of suction upon our body, drawing out its vital heat. It strikes me as one of the barbarisms of vulgar belief that cold bedrooms are considered magazines of health; they are rather breeders of disease, unless they also have ventilation. People go to sleep in air-tight, cold rooms, in the belief that it is healthy, particularly if they have the bedroom well aired in the morning. Yet all the night long the air in the room stays unmoved and gets slowly poisoned, while the evaporation of the body settles upon the walls and makes them more and more air-tight. If any one fresh from the outer pure air enters such a room he is almost nauseated by the vitiated atmosphere; even as that open air recluse of Walden Pond, Henry Thoreau, used to hold his nose when passing dwelling-houses, the doors of which were opened for the first time in the morning. Cold rooms in winter time, let me add, are not only uncomfortable for the poor but active agents of producing disease; and the phenomenon of epidemics in cold weather—which has excited so much wonder—is a very natural consequence of neglected ventilation; and it is as one of the chief means of checking these winter diseases and epidemics, that Doctor Von Pettenkofer urges governments, above all things, to supply the poor with fuel in winter. For to have ventilation there must be difference between the air in the house and the outside air; just as to get ventilation by means of chimneys you must have fires in the chimneys. It is only when this difference exists, when there is a cold layer of

air pressing the warmer air upward, that ventilation results. But in his cold room, the poor man has no ventilation and he is thus forced by the cold, not only to freeze, but also to breathe a vicious atmosphere.

An erroneous idea seems to prevail in regard to the healthfulness of our sleeping apartments; it is often asserted that they should be cold in order to be healthy; in alluding to this a medical journal states that "A moderate amount of heat is needed in a bedroom, but *that* moderate amount is needed in winter time. There is no advantage in going to bed in a cold room, nor in sleeping in a cold room, nor in getting up and dressing in a cold room. Persons may survive it, many have lost health by it. To have the chill taken off the air on going to bed and when dressing, is comfortable and healthful. A room under forty-five degrees is a cold room for a sleeping apartment, and sleeping in an in-doors atmosphere lower than that is always hurtful, and always positively pernicious, for the simple reason that such a temperature causes the carbonic acid gas of a sleeping apartment to condense and settle in the lower part of the room, where it is breathed into the lungs with all its pernicious results. Sleeping in a room cooler than above named is especially dangerous to feeble, aged, or invalid persons, as it tends to cause inflammation of the lungs. Persons may sleep out of doors with impunity when the thermometer is many degrees lower, because the out-door air is pure, is full of life, full of oxygen, without any admixture of in-door poison, and

hence gives a vigor of circulation which keeps the whole body warmed to its natural point, resisting cold and all diseased conditions."

Cold, free, fresh air outside the house is indeed quite a different thing from cold, putrid air inside the house; a fact which, in examining the causes of diseases, is too often overlooked. Chimneys and flues that have no fire in them, far from ventilating, may rather become the means of hoarding and sweeping down disease into the room.

TWO FACTORS NEEDED TO MOVE AIR.

That two factors are needed for the proper moving of air should never be forgotten. A means of escape of foul air, and an inlet of fresh, pure air; and that the means of making these two factors operate upon each other is heat.

Thus, as Doctor Von Pettenkofer wisely remarks, do the walls speak to us of a life of their own; and Shakespeare was not over extravagant, after all, when he represented the wall as speaking and disclosing its aperture, through which Pyramus and Thisbe (the human body inside the wall, and the air outside), spoke to each other, kissed each other, and committed the like absurdities.

I have dwelt perhaps to too great an extent on the ventilation which a house may be made to furnish of itself, by means of its material, if properly dried after its erection, and kept dry afterward. This, however, is only a small item, and the chief ventilation of a house must always be procured by artificial means; that is to say, by

chimneys in one form or another, and these means must be increased in proportion to the exigencies of the building.

Thus it is estimated that there is required for every person each hour:

In Hospitals, for ordinary patients, from 2,000 to 2,800 cubic feet of fresh air.

In Hospitals, for wounded patients, 4,300 cubic feet of fresh air.

In Hospitals, for epidemic patients, 5,600 cubic feet of fresh air.

In Prisons, 2,100 cubic feet of fresh air.

In Workshops, from 2,000 to 3,500 cubic feet of fresh air.

In Barracks, from 1,000 to 1,650 cubic feet of fresh air.

In Theatres, from 1,400 to 2,400 cubic feet of fresh air.

In Meeting-houses, from 1,000 to 2,000 cubic feet of fresh air.

In Schools for children, from 400 to 500 cubic feet of fresh air.

In Schools for adults, from 800 to 1,000 cubic feet of fresh air.

Large as these figures appear, they have been determined in two ways—by mathematical calculation, and by innumerable experiments all of which have corroberated the independent mathematical calculation. Ranke, in his "Grundzuge der Physiologie" (Elements of Physiology), fixes the average quantity at sixty cubic metres, or 2,118 cubic feet per hour for each individual, as the necessary minimum amount. In cities it has to be con-

sidered, moreover, that each gas-burner needs the introduction of from four to five thousand cubic feet of fresh air every hour, facts, all of which it is necessary that the architects should keep in mind in order to secure a sufficiency of artificial means of ventilation whereby to furnish this amount of air, and furnish it in a proper degree of purity and warmth to make it conformable to the requirements of the human body. Of course architecture is mainly an art, I am quite well aware, and I am, perhaps, more sensitive than many of my profession upon this point. I desire that our houses, as well as all our buildings, should express *externally* and *internally* beauty,—that harmony, symmetry, proper proportion of sizes, colorings, and the like, which fill the eye with that supreme satisfaction, whereby men are lifted, as by the utterances of religion, to a higher and nobler life.

ARCHITECTURE MUST NOT BE WHOLLY ÆSTHETIC.

But there is this about architecture, that it must not give absolute and undivided supremacy to its æsthetical side. The sculptor, who models a statue, has only beauty in view; the architect, who builds a house, should primarily consider its adaptability to health and comfort, and then proceed to mould those ideas of health and comfort into the utmost possible picture of beauty. It is sometimes argued that ventilation is expensive, and that its cost precludes the general introduction of complete arrangements. To secure a considerable degree of salubrity in a dwelling at a trifling expense, is comparatively

an easy achievement. In all the rooms flues may be constructed to allow the heat and the combustion of the gas to escape, and gas-burners may be placed within the ventilating flues and chimney flues over the mantel-piece, to create a strong current in order to facilitate ventilation. These can be covered (where they would necessarily show in the rooms) by pictures hung on hinges in front of the openings having the gas-burners within. The same mode of heating the ventilating flues can be adopted for ventilating other domestic conveniences. Openings can be made and registers put into the partitions communicating with the halls, and these can be ventilated by skylights with ventilating cowls; these cowls will facilitate the outward and prevent an inward current. In case it should be desirable to close all the windows and doors of the rooms, perforated iron blocks can be built into the exterior walls, upon a level with the flooring beams, and the space between two beams becomes a conduit for the fresh air, the outlet for it being placed (where possible) under the bed, by having a piece of the base board hung on hinges, with an opening behind it to admit the air. The placing of the ventilating registers in the ceilings instead of in the side walls of rooms, forms a feature of ornament, whereas in the side walls they are usually difficult to arrange without being an eye-sore. For each flue in the ceiling a gas-light put into the same flue, upon and accessible from the floor above, heats the ventilating flue, and furnishes it with a more rapid current, and increased ventilation when desirable. The ventilating flues may

also be connected with the heating flues by branch pipes for the purpose of exhausting the heat into the ventilating flues when it becomes necessary to shut off the heat, as it has often proved dangerous to shut the hot air registers and retain the heat within the flues. At the same time this exhausting of the superfluous heat into the ventilating flues greatly facilitates the draft of the ventilating flues. The main stairway of a house can also be made to form a great ventilating shaft, over which is formed a glass dome resting upon a cornice of stucco. The frieze of this cornice may be formed of perforated wood-work, representing a fine study of tropical foliage and birds.[1]

For the supply of fresh air to each room special flues can be provided and connected with a steam heating apparatus by which the air is warmed before it passes into the rooms.

IMPORTANCE OF GOOD DRAINAGE.

The matter of drainage is also to be well considered. All the soil and drain pipes should extend to the level of the roof, and the roof be so graded in various places as to conduct the rain water to the soil and drain-pipes; and

1 This, in a private residence built under the supervision of the architect, gives, at first appearance, the impression of elaborately carved work. It is made of flat wood, sawed out to give the outline of the foliage and birds, and the shading and detail of forms have been done in color. Through the perforations of this ornamental work the foul air passes into the space between the glass dome and the outer skylights, and it finds its exit through a ventilating cowl three feet in diameter. The glass dome is illuminated. The gas-lights answer the double purpose of features of ornament as well as great assistants in the ventilation, especially upon the occasion of a large entertainment when the house is filled with people, when by means of the heat of the gas, the impure air is being constantly drawn toward the dome, where it finds its exit. The gas flames cannot be seen below the dome.

as a further precaution against any smell from the drain, they should be connected by a ventilating pipe with the smoke flue beyond the Range, to guard against any odors that might otherwise escape from the drain pipe in case of their breaking. The importance of good drainage cannot be valued too highly in connection with public health. We find that the great plague of London and Westminster, in the 17th century, as shown by the parish registers of the Church of St. Margaret, has been attributed to the want of sufficient drainage and to the narrowness of the streets and lanes. A more recent and convincing proof is the late sickness of the Prince of Wales, caused by the insufficient drainage of Londesborough Lodge.

It is now fully admitted that warming and ventilating should be defined more particularly than has commonly been the case, previous to the erection of a new building, and incorporated with the structure from its first foundation. Since proper ventilation depends so largely upon a system of heating, I should perhaps say a few words upon several modes in use. The physiological effects resulting from particular modes of warming and ventilating inhabited rooms form a most interesting subject of inquiry and are not only interesting as matters of scientific research, but they closely concern every individual member of the community. It is a question which affects not merely the personal comfort of individuals, but according to the opinion of the ablest pathologists, it influences the health and affects the duration of life. Our dwellings are mostly heated by hot-air furnaces. The hot-air fur-

nace in its present form was first employed at the end of the last century by a Mr. Strutt of Belper, near Derby, for warming his cotton mills, and was soon after introduced into general use. Its distinctive feature is that its application of fire-heat to metallic surfaces is a direct one without the intervention of either water or steam; and it is this feature which in my view makes it utterly objectionable, except perhaps in cases where the object is merely to produce a drying and warming effect of considerable intensity for specific manufacturing or laundry purposes. In all other cases it is to be utterly condemned. Indeed, there seems to be a general concession that the the heat produced by hot-air furnaces is of the most injurious character in its influence upon health. Dizziness, coldness, and languor in the extremities, feebleness of pulse, fainting fits; such are some of the symptoms that have everywhere been noticed to accompany this mode of heating, undermining health in its most susceptible department, the nervous organization. Air heated thus artificially without contact of water, acquires an aridity which causes it rapidly to absorb moisture from the skin and lungs of persons exposed to its influences, and the evaporation, by its refrigerating effect, contracts the blood-vessels at the surface, while other parts not being exposed to this influence become in consequence surcharged with the fluids which are repelled from the extremities.

"There is a risk of dryness in air from highly heated metallic surfaces," says Professor Faraday, "which leads

me to prefer it warmed by steam or hot water which gives lower temperature; sixty-five degrees by the latter mode will not cause the air to lose any of its humidity, but by the former mode the air requires vapor of water to correct it." All observers, indeed, are agreed on this injurious characteristic of heating with hot-air furnaces, as causing the absorption of the necessary humidity in the air of rooms, and thus inducing the nervous disorders before mentioned as well as being the cause of many other diseases. For as the dew-point[1] of the air in a room rises beyond its proper degree, the dryness of the atmosphere draws a quantum of moisture from one body altogether beyond what the body can well spare. The most healthy state of the atmosphere can be obtained only when the dew-point of the air is not less than ten degrees nor more than twenty degrees Fahrenheit lower than the temperature of the room. When these limits are exceeded the air will be either too dry or too damp for healthy respiration. Moreover, this dryness of the air which is the invariable result of hot-air furnaces deprives the atmosphere to an inordinate extent of positive electricity, whereas the evaporation produced by steam heating excites it, and thus relieves the unpleasant and injurious effect of close rooms. "So greatly does evaporation affect the electric condition of the air," says Mr Hood, "that the diurnal variation in the quantity of

1 Dew-point is that thermometric temperature of the atmosphere at which vapor is condensed. By exposing a cold body to the air, a fine dew is deposited on its surface, and by observing the temperature of this cold body, the exact quantity of vapor contained in the air at that time is ascertained.

electricity follows nearly the same course as the exhalation of moisture, and evaporation is considered to be the principal course of atmospheric electricity." Then, again, the air is always full of myriads of particles of animal and vegetable matter partly emanating from our bodies, and most of which are easily decomposed by heat, and experiments have demonstrated that the dry heat from metallic surfaces operates particularly most injuriously in effecting this decomposition. Hence the unpleasant smell in buildings thus heated, the atmosphere becoming a mass of putrid noxious matter. "And not only," says Mr. Hood, " will the hot-air furnace, which is particularly liable to these objections, act powerfully in decomposing the floating particles of extraneous matter contained in the air, resolving them into sulphuretted, phosphoretted, and carburetted hydrogen with various compounds of nitrogen and carbon, but it will likewise decompose a portion of the vapor contained in the air, absorbing the oxygen and liberating the hydrogen. To this must be added that the iron of the furnace, when heated to a glow, is rendered penetrable to the various hydrogen and carbonic gases of the burning material, which thus fill the air with additional impurities, and far from being an assisting agent in the ventilation of a building, the hot-air furnace considerably adds to the difficulty of providing the necessary ventilation. This is still more the case when the fire is kept high, for it has been fully established that air heated beyond a temperature of 212°-250° is unfit for breathing, and in furnaces it

is often heated to a temperature of 300°-400°, at which it is, of course, utterly valueless for respiration. Indeed, it is almost an impossibility with furnaces to get air heated within the limit specified. Surely it is difficult enough to provide large public buildings with ventilation sufficient to supply them with pure air, without increasing the difficulty by the introduction of a heating apparatus that of itself tends to fill the air with impurities while it does not assist at all in the ventilation, and this is particularly to be remembered in the construction of public halls, court-houses, churches, etc., for vitiated air invariably produces those stupefying effects of a narcotic dullness, drowsiness, headache, nausea, etc., and all such feelings which are utterly destructive of the state of mind above all needed in such buildings. It is not, however, simply a question of comfort, but a most important question of health that is involved in this matter of excluding furnaces from our public and private buildings. Few persons fully realize the vast consequences which result from impure air, and how seriously the duration of human life is affected by want of proper attention to this important subject. Dr. James Johnson says, that ague and fever, two of the most prominent features of the malarious influence, *are as a drop of water in the ocean* compared with the other less obtrusive but more dangerous maladies that silently disorganize the vital structure of the human fabric under the influence of this deleterious and invisible poison. Indeed, to compress the statement in a few words: Carbonic acid intoxication is the most terrible agent of disease,

insanity, and immorality which we have to deal with, all the more terrible and dangerous as it is indulged in by all classes, by all ranks. The inhabitant of the most wretched house on Baxter Street clings to the inhalation of impure air with the same fervor and love as the owner of the finest dwelling on Fifth Avenue, who carefully shuts out pure air under the pretext of excluding "draughts," and wraps himself up in the poisonous atmosphere as if it were of all things his best and dearest friend; and what I desire particularly to insist upon as one of the most effective elements in the spread of this carbonic acid intoxication is the hot-air furnace. It not only impairs ventilation but assists in the adulteration of air. To put a hot-air furnace in your house is like furnishing your milkman with chalk, or your wine merchant with strychnine.

While I have spoken against the use of furnace heat upon health principles, I am aware that it is not within the means of every one to have his house heated by steam or hot water. It would greatly mitigate the evils of furnaces if in houses where *one* furnace is commonly thought sufficient, *two* of them were used, in order to obtain the necessary heat without overheating the iron surfaces of the furnace and without burning the air.

In the construction of the furnace, cast iron should be avoided, wrought iron or soap stone should be used. In the distribution of furnace heat in houses the number of openings by which the heat is emitted into the rooms should be considerably increased, there should be several

openings in an ordinary sized room instead of one, as is now the practice, so as to allow a greater diffusion of the heat.

As I said at the beginning, sanitary architecture is a matter of transcendent importance to the human race. Vitiated atmosphere is quite as injurious and stupefying as the worst alcoholic drinks. It spoils every dinner, it kills sleep. It is the greatest enemy of the preacher, in that it makes people stupidly drowsy, and puts them asleep. It disarranges the whole natural organism. The judge and jury in a court-room filled with pestilential air, as most of our court-rooms are, are as much under the influence of a deathly narcotic as the inhalers of opium smoke.

The poorer classes of our large cities suffer probably most from this demoralizing breathing of polluted atmosphere. It is well to preach temperance, but is it not also well and of preëminent necessity to preach and procure clean, pure air, and healthy sunlight? Is it not worse than folly to refuse the cup from which your friend has drunk, and at the same time breathe into the inmost recesses of your body the air from the lungs of a promiscuous crowd, whether in rooms, halls, churches, or street or railroad cars, or from a pestilential neighborhood? When we contemplate the almost universal fear of draught, that is to say, fresh air, which pervades almost all classes of modern society, and from the effects of which our little children are made to suffer even more yet than the adult generation, it seems that nothing could

be more timely than a crusade against this carbonic acid intoxication, to which men seem so hopelessly given. For this breathing of foul air is nothing but an intoxication, accompanied by all its evil effects, want of appetite, headache, sleeplessness, etc., and the cause of most of those sicknesses which are foolishly ascribed to pure air under the name of draughts. In conclusion allow me to say one word in regard to drainage, whereby I mean to include any kind of communication passing between the house and the ground upon which it is built. This ground is also porous (the more so, likewise, in proportion to its dryness), and is therefore also somewhat of a ventilator. At the same time, in the close streets of our large cities, where gas-pipes, sewers, etc., run through it to a vast extent, it is also filled with innumerable agents of danger to health, all of which require the most careful watching on the part of the architect, and against many of which science has not as yet provided. Particularly in winter when the house, if heated, draws, as it were, the atmosphere and gases of the adjoining ground into its rooms, are these elements dangerous and conspire to spread epidemics.

Equally important to a good system of heating is that of plumbing. Typhoid fever and dyphtheria are invariably produced by the escape of sewer gas caused by defective plumbing. The pipes should be of sufficient size and the joints well caulked and secured, waste pipes branching from a main pipe should not extend in a horizontal direction more than five or six feet without having

a separate air or ventilating pipe for the "trap," otherwise the trap is liable to be syphoned. Rain water pipes should not be depended upon to ventilate the soil pipes; during severe rain storms they become overcharged with water and closed against the escape of air, and the sudden increase of water in the sewer compresses the air and forces the gases through the traps into our buildings. Another cause of the escape of sewer gas into our buildings is the evaporation of the water in the traps when the houses are not occupied. It ought to be the duty of every person left in charge of an unoccupied building to let the water pass through the pipes of every wash basin, bath, sink, or water closet once a day of sufficient quantity to fill the traps.

The basins of water-closets should not be of a conical form as commonly used, to which the excretions are apt to adhere and largely contribute to the impurity of the atmosphere of houses. The basins should be of a cylindrical form with perpendicular sides admitting of the excretions to fall into the water at the bottom without coming in contact with the sides of the basin and which would thus be more readily kept clean.

To guard against defective plumbing work, the same ought to be tested before it is made use of. The test to consist in stopping the waste pipes at the bottom, and all other outlets and before the wash basins, sinks, water closets, etc., are connected, to fill all the pipes with water, this would produce sufficient pressure to test the quality of the waste and supply pipes and would prove

whether the joints were perfect or not and secure in this way an important agent in the ventilation of our buildings.

I suppose you are all familiar with the case mentioned by Dr. Reid: where about fifty members of one of the Royal Society Clubs at Edinburgh dined in an apartment which he had constructed, so that the product of the gas combustion and the vitiated air were removed by a ventilating pipe, and large quantities of a mild scented fresh atmosphere constantly passed into the room. The gentlemen present at the banquet were unaware of this arrangement, which had such an effect upon them that the caterer was struck with the enormous and increased amount of food and wines dispatched with utmost ease and nonchalance by the same men whom he had so often seen languishing over a dinner in the same, but foul-aired room. Not one of them knew he had displayed an unusual appetite; and no one complained of headache or other indisposition at that dinner or afterward.

Thus, in the most manifold ways is public health connected with architecture; and thus does the Science of Hygiene depend upon the coöperation of the builder. If, by the statement of a few general principles and in a necessarily brief and fragmentary manner, I have succeeded in illustrating the coöperation and mutual dependdence of this most noble art and this most beneficent science, I shall feel amply repaid for my endeavors.